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(באנגלית) (English)
Gas purge valve

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* בקשת חלוקה Application of Division	* בקשת פטנט מוסף Appl. for Patent of Addition	* דרישת דין קדימה* Priority Claim		
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משחרר אויר

Gas purge valve

A.R.I. Kfar Charuv Water Supply Accessories

א.ר.י. כפר חרוב אביזרי מים

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C. 140691

GAS PURGE VALVE

FIELD OF THE INVENTION

The present invention generally relates to fluid flow valves and is particularly, but not exclusively, concerned with such valves which are designed to serve as gas discharge valves or gas purge valves.

BACKGROUND OF THE INVENTION

Air purge valves are designed to be installed in liquid flow systems such as, for example, water main distribution lines or sewage collection systems, or liquid tanks, and are intended to discharge air (typically in water supply systems) or other gasses (e.g. in sewage systems or thick liquid supply systems), thus avoiding the formation and accumulation of gas pockets and bubbles which interfere with the liquid flow and which can also damage accessories and components of the liquid system. On the other hand, when the liquid system is drain, it is required to air the lines so as to avoid their collapse under rabid vacuum build-up.

A basic requirement for gas purge valves is their ability to discharge effectively and rapidly both large and small quantities of gas whilst, at the same time, being or becoming sealed against liquid discharge. Conventional air purge valves are formed with a gas discharge outlet through which the gasses are discharged but which become sealed against liquid discharge by a float located in a valve housing and which becomes pressed against the outlet so as to seal it with a rising level of liquid in the valve housing.

Such a valve, when provided with a relatively small discharge outlet, is effective for the discharge of small quantities of gas but cannot cope where large quantities have to be discharged. Where, however, in order to render the valve

capable of handling large quantities of gas it is provided with a large discharge outlet (and, consequently, a large dimensioned float), problems arise in order to ensure that the valve can readily discharge rapidly relatively small quantities of gas after the discharge outlet has been sealed against liquid outflow. Thus, once the valve housing is filled with liquid and the float has been pressed against the relatively large outlet so as to seal it, the valve will only reopen once the pressure in the housing has dropped to atmospheric pressure and, in consequence, such a valve cannot be used for the continuous venting of relatively small amounts of air.

Moreover, such valves have the drawback of being substantially sensitive to the presence of dirt, grit, etc., particularly where manufacturing tolerances or erosion of various components, built-up of dirt or scale, etc., greatly influence the behavior of the float and its response to changes of the fluid flowing there through (liquid or gas). Thus performances of such air purge valves are somewhat inaccurate and may malfunction.

A large variety of gas valves have been proposed, for gas purge valves capable of effectively and rapidly discharging both relatively small and large quantities of gas. Such a proposal is to be found in U.S. Patents Nos. 4,770,201 and 6,105,608. Prior art arrangements, whilst allowing for the effective and speedy opening of the outlet aperture for speedy discharge of relatively small quantities of gas as well as its complete opening for the discharge of large quantities, are nevertheless vulnerable in particular when installed on lines through which dirt flows along with the liquid, e.g. sewage lines.

However, in valves of the type comprising a float member received within the valve housing and being articulated with an outlet sealing means, there is provided some guidance to facilitate regular and smooth displacement of the sealing means. For that purpose it has been suggested to provide a support rod coaxially extending with the sealing means and axially displaceable within an external support bushing. This arrangement however is prone to malfunctioning upon deformation of the support rod and upon entering of dirt to the vicinity of the bushing. Even more so, the axial guidance does not assist in displacement of the sealing means but rather may cause an obstacle to normal operation thereof.

SUMMARY OF THE INVENTION

It is thus an object of the present invention to provide a gas purge valve in which the sealing member is externally guided so that the valve will operate trouble-free also under extreme dirt conditions.

According to the present disclosed technology there is provided a gas purge valve comprising a housing formed with an inlet and an outlet, said outlet formed in turn with a valve seating, and a sealing assembly comprising a sealing member displaceable between an open position and a closed position; wherein the sealing assembly is supported by an external support lever (pivotable/support arm) mechanism, i.e. extending outside said housing, to thereby displace the sealing assembly into sealing engagement with said valve seating at the closed position.

According to a particular design of the present invention the gas purge valve comprises a housing fitted with an inlet being in flow communication with a float chamber within the housing, and an outlet formed at an upper end thereof; a sealing assembly for sealing said outlet, and a float disposed within said float chamber articulated to the sealing assembly; said sealing assembly being carried at a first end of an external support lever having a second end thereof pivotally attached to the housing.

The float member is directly or indirectly articulated to the sealing assembly. According to one arrangement the float is coupled to the sealing assembly by a rigid link and according to another embodiment the link is flexible (e.g. a cord, etc) or comprises one or more rigid links with at least one degree of freedom. According to a different arrangement the float is directly articulated to the sealing assembly or to a component associated therewith.

Furthermore, the support lever may be received within a water-tight casing, wherein the casing is received within an outlet duct extending from the valve outlet and being in flow communication therewith.

According to an improved modification of the invention, the valve outlet is of the combined type comprising a major, kinetic outlet for high flow rate gas flow, and an auxiliary, automatic outlet for low flow rate gas flow. By a particular design,

the auxiliary outlet comprises an aperture adjoined by an auxiliary valve seating, said auxiliary outlet aperture being substantially less in area than the major outlet aperture; a flexible closure membrane secured at one end to the sealing member of the major outlet and adapted to be biased against said auxiliary valve seating so as to seal said auxiliary outlet aperture; the float member being articulated to an opposite end of said membrane.

By one particular design, the auxiliary valve seating has a substantially elongated slit-like shape, communicating at one end thereof with the major outlet aperture.

The support lever can be provided with arrangements for altering the moment of rotation about a pivoted end thereof and/or may comprise dampening arrangements.

According to one particular embodiment, the support lever is pre-loaded in either or both directions. In one sense, the support lever may be biased into direction so as to open the valve (i.e. to disengage the sealing assembly from the valve seating) so as to reduce or prevent hammering. Biasing the support lever in an opposite sense i.e. into engagement of the sealing assembly with the valve seating, entails tight sealing. Said pre-loading may be adjustable.

By a specific arrangement, the pre-loading mechanism comprises an axle attached to the lever and received within a casing fixedly supported by the housing, a coiled spring having one end thereof engaged with said axle and an opposed end thereof engaged with a tension setting nut rotatable with respect to said axle in a first sense to tension the spring, and in an opposite sense to loosen the spring. Other arrangements may include provision of various types of springs, dampeners, balance-weights, dynamic weights (e.g. water weight, etc).

By one particular application, the valve according to the invention is used in conjunction with a sewage system.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, some embodiments will now be described, by way of non-limiting examples only, with reference to the accompanying drawings, in which:

Figs. 1 illustrate a gas purge valve according to a first embodiment of the present invention, wherein:

Fig. 1A is an isometric view of the valve in a closed position; and

Fig. 1B is a sectional isometric view of the valve in its open position;

Figs. 2A and **2B** illustrate a top portion of the valve of Figs. 1 in its closed position, in an isometric view and in a sectioned view, respectively;

Figs. 3A and **3B** illustrate the valve of Figs. 1 in its partially open (automatic) position, in a sectioned view and in an isometric sectioned view, respectively;

Figs. 4A and **4B** illustrate the valve of Figs. 1 in its fully open (kinetic) position, in a sectioned view and in an isometric sectioned view, respectively;

Figs. 5 illustrate a gas purge valve according to a second embodiment of the present invention, wherein:

Fig. 5A is a side view of the valve: and

Fig. 5B is a longitudinal sectioned, mirror image, of the valve of Fig.5A ;

Figs. 6A to **6C** are sectional views through a top portion of the valve of Figs. 5, illustrating the sealing portion in a closed position, a partially open (automatic) position, and in a fully open (kinetic) position, respectively;

Figs. 7A to **7D** illustrate a biasing mechanism associated with the support lever of a valve according to the present invention, wherein:

Fig. 7A is an isometric view of the top region of the valve;

Fig. 7B is an isometric view of the biasing assembly in larger scale, its casing made translucent;

Fig. 7C is an isometric view of the biasing assembly detached from the valve housing, its casing made translucent; and

Fig. 7D is a sectioned isometric view of the biasing assembly of Fig. 7C;

Fig. 8A is a sectioned view of a gas purge valve according to another embodiment of the present invention, illustrated in a normally-closed position; and

Fig. 8B is an enlargement of the top portion of the valve, in its closed position.

DETAILED DESCRIPTION OF THE INVENTION

Attention is first directed to Figures 1A and 1B of the drawings illustrating a gas purge valve in accordance with one embodiment of the present invention, generally designated **10**, which in the present example is of the type fitted for cooperation with a sewage or waste line.

The valve **10** comprises a frustoconical (though other shapes are possible too) metal housing **12** comprising a base portion **14** and an upper portion **16** secured to one another by a coupling flange **20**. The housing is formed with an inlet port **24** and comprises a base flange **26** for attaching the housing to the liquid line. An outlet port **30** is formed at a top cover member **32** flanged to the upper housing portion **16** by means of articulating flange **34**.

A sealing assembly generally designated **38** extends within the housing and is articulated to an external support lever **42** as will be explained in further detail herein below. Pivotally supported from the sealing assembly **38** there is a float member **46** (Fig. 1B) suspended by a rigid connecting rod **48** pivotally secured to the sealing assembly **38**.

However, it is appreciated that the float member **46** may be directly or indirectly articulated to the sealing assembly **38**. According to other embodiments (not shown) the link is flexible (e.g. a cord, etc) or comprises one or more rigid links with at least one degree of freedom. According to a different arrangement (not shown) the float member may be directly articulated to components associated with the sealing assembly, e.g. support member **72** or pivot bar **80** (Fig. 2B).

For better understanding the particular design of the valve outlet **30** and the sealing assembly **38**, further attention is directed to Figs. 2A and 2B. The outlet **30** comprises a circular major outlet **52** defining a major valve seating **54** and further

comprising a slit-like auxiliary outlet **56** defining an auxiliary valve seating **58** (Fig. 2B).

The support lever **42** is pivotally secured at a first end thereof **60** to a support extension **62** fixedly attached to the housing **12**. A second end **64** of the support lever **42** is articulated to the sealing assembly **38**.

The sealing assembly **38** comprises a major sealing member **70** (e.g. made of a resilient material) retained by a rigid support member **72** and is clamped by a top retaining member **74** whereby the sealing member **70** has an exposed edge for sealingly bearing against the boundaries of the major valve seating **54** (Fig. 2B). Sealing member **70** is integrally formed in the present example with a strip-like sealing membrane **78** having one end thereof articulated to a free end of a pivot bar **80**, the latter having an opposed end thereof pivotally secured at **82** to the support member **72**. Connecting rod **48** of the float member **46** is pivotally secured at **86** to said pivot bar **80**. The valve **10** in accordance with the present invention has three principle positions as respectively illustrated in Figs. 2, 3 and 4. The first position is illustrated in Figs. 2A and 2B depicting the valve in its closed position, wherein the sealing member **70** tightly bears against the valve seating **54** of the major outlet **52** and similarly the strip-like closure membrane **78** sealingly bears against the auxiliary valve seating **58** of the auxiliary outlet **56**. This position takes place when liquid enters the housing **12**, applying buoyancy force on float member **46** which by means of rod **48** ensures tight sealing engagement of the sealing member **70** and the sealing membrane **78**. It is to be appreciated that the auxiliary outlet may be otherwise formed then a slit-like aperture and may adjoin the major outlet rather then be bounded thereby. It is also to be understood that the valve may be a so-called kinetic valve, suited for gas flow at high flow rates and not comprising the so-called automatic portion, i.e. suited for low flow rate gas flow.

Turning now to Figures 3A and 3B, the valve **10** is illustrated in the so-called automatic position wherein the strip-like sealing membrane **78** detaches from the auxiliary outlet **56** whilst the sealing member **70** remains tightly engaged with the major valve seating **54**. This situation occurs while the float member is only

partially immersed in liquid within the housing. When the auxiliary outlet **56** is open, it is suitable for discharging gases from the valve also at significantly low flow rate, also when the pressure within the housing is high.

In the position illustrated in Figs. 4A and 4B the valve **10** is illustrated in a fully opened position also referred to as a kinetic position wherein the sealing member **70** detaches from the major valve seating **54** in the absence of liquid within the housing **12**. The situation is useful for allowing air egress in to the system, e.g. upon draining of the system. Alternatively, this position is useful when the system is filled with a liquid, in order to discharge amounts of gas (typically air).

Of particular importance in the embodiment depicted in Figs. 1 to 4 is the externally extending support lever **42** which is not influenced by flow or pressure considerations occurring within the housing and even more so, dirt typically flowing in such systems (in particular where the valve is used with a sewage system) does not affect the support of the sealing assembly and proper sealing is obtained.

It is further appreciated that the float member may be directly articulated to the sealing assembly **38**, e.g. by omitting the connecting rod **48**.

It is also noted that the external support lever **42** enables displacement of the sealing assembly **38** to significantly evacuate the outlet port **30** (Fig. 4B) to thereby facilitate gas flow at high flow rates.

Further attention is now directed to Figs. 5 to 7 illustrating another embodiment of a valve in accordance with the present invention wherein like components have been designated same reference numbers shifted by 200.

Turning first to Figs. 5A and 5B, there is illustrated a valve **210** comprising a housing **212** having a frustoconical shape formed with an inlet port **224** and an outlet **230** (Fig. 5B). The valve **210** is fitted with a sealing assembly **238** from which a float member **246** is suspended by means of a rod **248**. It is further noted that the sealing assembly **238** is supported by an external support lever **242** pivotally secured at **260** via a pre-loading mechanism **101** to a support extension

262 fixedly attached to the housing 212. The particular design and purpose of the pre-loading mechanism 101 will be apparent hereinafter by particular reference to Figs. 7A to 7B.

It is further noted in Figs. 5 and 6 that the external support lever 242 extends through an outlet duct 106 extending from the outlet port 230 to an outlet opening 108. If desired, a screen may be fitted at the outlet 108 (not shown) to prevent ingress of insects and tampering of the sealing assembly 230 (e.g. in a water supply system).

With further attention now directed to Figs. 6A-6C the valve 210 is illustrated in a completely closed position (Fig. 6A) where both the major outlet 230 and the auxiliary outlet 256 are sealed. In the position seen in Fig. 6B the valve is in its partially open position wherein the major outlet 230 is sealed and the auxiliary slit-like outlet 256 is open. In Fig. 6C both the major outlet and the auxiliary outlet are fully open. These positions correspond with the respective positions illustrated in Figs. 2, 3 and 4, respectively.

As can further be noted in Figs. 6A-6C, the float connecting rod 248 is loosely connected to the connecting bar 280 of the sealing assembly 238 though there is provided a coiled spring 113 for dampening the direct coupling between the float member and the sealing assembly so as to minimize motion transfer from the float member to the sealing assembly during swinging and buoyant motion of the float member. As already mentioned before, the float member may be coupled to the sealing assembly by other arrangements which mute the dangling motion of the float member.

Further attention is now directed to Figs. 7A-7D illustrating the pre-loading mechanism 101 comprising a sealed casing 115 secured to the housing and to the support extension 262 (Fig. 7A). The external support lever 242 is formed with a pivot axle 119 coaxially received within the housing 115 wherein a coiled spring 121 has one end thereof 123 fixedly secured to the axle 119 (Fig. 7B) with its opposed end fixedly received within an attention adjusting member 127 formed with a hexagonal head 129 and where a set screw 131 projects through the casing

115 for arresting the adjusting member **127** at any angular position depending on the required damping force.

The arrangement is such that the support lever **242** is biased in a direction so as to displace the sealing assembly **230** into sealing engagement with the valve seating whereby the valve is suitable for use in particular as an air inlet valve, i.e. useful when a fluid conduit is drained, etc. The support lever may be pre-loaded in a variety of different ways, such as, for example, by weights (mass elements or liquid within the housing), elastic biasing means, dynamic weights (e.g. liquid chambers), etc.

It is noted that is also possible to provide a suspending arrangement for delaying motion of the sealing assembly into the sealing position. Such suspension may be obtained for example by providing a viscous or visco-elastic damping mechanism ,elastic means, to thereby sustain sealing engagement of the sealing member with the valve seat, to thereby reduce or eliminate hammering. However, it is to be appreciated that dampening means may be provided in addition or without pre-loading of the support lever, in any direction (i.e. closing or opening).

Further attention is now directed to Figs. 8A and 8B of the drawings, directed to a modification of a valve according to the present invention, generally designated **300**. The valve is similar to the valve of Fig. 1B, the major difference residing in that it is absent of a float member (**46** in Fig. 1B) and in that the sealing assembly is merely of the so-called kinetic type, i.e. adapted for gas flow at high rates.

According to the embodiment of Figs. 8A 8B the housing **302** is formed with an inlet **306** (not seen in Fig. 8A) and an outlet **308** formed in turn with an outlet valve seating **312** (best seen in Fig. 8B). A sealing assembly generally designated **316** comprises a sealing member **318** (e.g. made of a resilient material) retained by a rigid support member **320** and is clamped by a top retaining member **322**, whereby an exposed peripheral portion of the sealing member **318** is fitted for sealingly bearing against the boundaries of the valve seating **312**.

Sealing member **318** is coupled to a pivotal arm/support lever **326**, which is pivotally secured at a first end thereof **328** to a support extension **332** fixedly attached to the housing **302**. According to the particular illustrated embodiment, the sealing assembly is rigidly linked to the support lever **326**.

Support lever **326** is biased into a normally-closed position, e.g. by spring **330**, whereby the sealing assembly is in sealing engagement with the valve seating **312**. This structure provides a gas inlet valve, i.e. a valve admitting gas inlet into the valve housing e.g. upon draining of the line connected to the valve. As mentioned hereinabove, there may be provided various dampening means to reduce or eliminate hammering during operation of the valve.

Whilst several embodiments have been shown and described, it is to be understood that it is not intended thereby to limit the disclosure, but rather it is intended to cover all embodiments, modifications and arrangements falling within the spirit and the scope of the present invention, as defined in the appended claims, *mutatis mutandis*.

CLAIMS:

1. A gas purge valve comprising a housing formed with an inlet and an outlet, said outlet formed with a valve seating, and a sealing assembly comprising a sealing member displaceable between an open position and a closed position; wherein the sealing assembly is supported by an external support lever mechanism extending outside said housing, to thereby displace the sealing assembly into sealing engagement with said valve seating at the closed position

2. A gas purge valve according to claim 1 comprising a float member articulated to said sealing assembly within the housing, and being displaceable susceptive to liquid level within the housing.

3. A gas purge valve according to claim 2, wherein the float member is suspended from the sealing assembly.

4. A gas purge valve according to claim 3, wherein the float member is suspended from the sealing assembly by a rigid connecting rod.

5. A gas purge valve according to claim 4, wherein an end of the connecting rod is pivotally coupled to the sealing assembly.

6. A gas purge valve according to claim 4, wherein the connecting rod is spring-biased to dampen motion of the connecting rod.

7. A gas purge valve according to claim 1, wherein the support lever is coupled to the sealing assembly allowing freedom for the sealing assembly to self align with the valve seating at a closed position.

8. A gas purge valve according to claim 1, wherein the support lever is pre-loaded so as to effect engagement of the sealing assembly with the valve seating.

9. A gas purge according to claim 8, wherein pre-loading of the support lever is adjustable to thereby adjust the force required for sealing the valve.

10. A gas purge valve according to claim 1, wherein there is further provided a pre-loading mechanism for pre-loading the support lever so as to adjust the moment about a pivot end thereof.

11. A gas purge valve according to claim 10, wherein the pre-loading mechanism comprises an axle attached to the support lever and received within a casing fixedly supported by the housing, a coiled spring having one end thereof engaged with said axle and an opposed end thereof engaged with a tension setting nut rotatable with respect to said axle in a first sense to tension the spring, and in an opposite sense to loosen the spring.

12. A gas purge valve according to claim 11, wherein the tension setting nut is rotatably fixable at different positions so as to allow for adjusting the pre-loading setting.

13. A gas purge valve according to claim 12, wherein the casing of the pre-loading mechanism is water and dirt sealed.

14. A gas purge valve according to claim 1, wherein the support lever is biased in a direction to displace the sealing assembly into sealing engagement with the valve seating.

15. A gas purge valve according to claim 14, wherein the biasing force is adjustable.

16. A gas purge valve according to claim 1, wherein the support arm is fitted with a calibration mechanism to confirm that the sealing member is retained in a normally closed position and opens only upon vacuum within the housing.

17. A gas purge valve according to claim 1, wherein the support lever is provided with a control mechanism for adjusting the moment of rotation about a pivoted end thereof.

18. A gas purge valve according to claim 1, wherein the support lever is provided with dampening arrangements to dampen displacement of the sealing assembly into the closed or open position.

19. A gas purge valve according to claim 1, wherein there a suspension arrangement is provided for delaying displacement of the sealing assembly.

20. A gas purge valve according to claim 19, wherein the suspension arrangement comprises a viscous or visco-elastic damping assembly associated with a pivoted end of the support lever.

21. A gas purge valve according to claim 1, wherein the housing has a frustoconical shape.

22. A gas purge valve according to claim 1, wherein the support lever is received within a water-tight casing.

23. A gas purge valve according to claim 22, wherein the casing is received within an outlet duct extending from the valve outlet and being in flow communication therewith.

24. A gas purge valve according to claim 23, wherein an outlet opening of the duct is fitted with a screen.

25. A gas purge valve according to claim 1, for use in conjunction with a sewage system.

26. A gas purge valve according to claim 1, wherein the support lever comprises an indicator for generating indicia corresponding with the state of sealing assembly.

27. A gas purge valve according to claim 2, wherein the valve outlet is of the combined type comprising a major, kinetic outlet for high flow rate gas flow, and an auxiliary, automatic outlet for low flow rate gas flow.

28. A gas purge valve according to claim 27, wherein the auxiliary outlet comprises an aperture adjoined by an auxiliary valve seating, said auxiliary outlet aperture being substantially less in area than the major outlet aperture; a flexible closure membrane secured at one end to the sealing member of the major outlet and adapted to be biased against said auxiliary valve seating so as to seal said auxiliary outlet aperture; the float member being articulated to an opposite end of said membrane.

29. A gas purge valve according to claim 28, wherein the auxiliary valve seating has a substantially elongated slit-like shape, communicating at one end thereof with the major outlet aperture.

30. A gas purge valve according to claim 29, wherein the flexible closure membrane adapted for sealing the auxiliary outlet aperture, is integrally formed with the sealing member adapted for sealing the major valve outlet.

31. A gas purge valve according to claim 29, wherein the opposite end of the closure membrane is articulated to one end of a pivot bar pivotally secured at an opposed end thereof to the sealing member of the major outlet, and articulated to the float member.

32. A gas purge valve according to claim 31, wherein the float member is coupled to the pivot bar via a connecting member.

33. A gas purge valve according to claim 29, wherein the major outlet sealing member is retained by a support member whereby the sealing member has exposed edges for bearing against the boundaries of the major valve seating.

34. A gas purge valve according to claim 33, wherein one face of the exposed edges bears against a bedding of the support member, whilst an opposite face thereof is fitted for sealing engagement with the boundaries of the major valve seating.

35. A gas purge valve according to claim 2, wherein the valve outlet comprises first and second outlet apertures respectively bounded by first and second valve seatings, said first aperture being of substantially elongated slit like shape, communicating at one end thereof with the second outlet aperture and being substantially less in area than the second aperture; a flexible closure membrane secured at one end to a sealing member for said second outlet and adapted to be biased against said valve seatings so as to seal said outlet apertures; the float member being articulated to an opposite end of said membrane.

36. A gas purge valve according to claim 35, wherein the sealing assembly comprises a sealing member for sealing engagement with a seating of the major outlet, and a flexible closure membrane secured at one end to said sealing member and adapted to be biased against a seating of the auxiliary valve outlet so as to seal said; an opposite end of said membrane being articulated to the float member.

37. A gas purge valve comprising a housing fitted with an inlet being in flow communication with a float chamber within the housing, and an outlet formed at an upper end thereof; a sealing assembly for sealing said outlet, and a float disposed within said float chamber and being attached to the sealing assembly by a rigid

link; said sealing assembly being carried at a first end of an external support lever having a second end thereof pivotally attached to the housing.

38. A gas purge valve comprising:

a housing having a valve inlet and a valve outlet;

a valve seating defined at said valve outlet;

a sealing assembly comprising a sealing member adapted for sealing engagement with said valve seating;

a float member articulated to said sealing assembly within the housing, and being displaceable susceptive to liquid level within the housing; and

an external support lever pivotally secured at a first end to the housing and having an second end articulated to the sealing assembly.

For the Applicants
REINHOLD COHN AND PARTNERS
By:

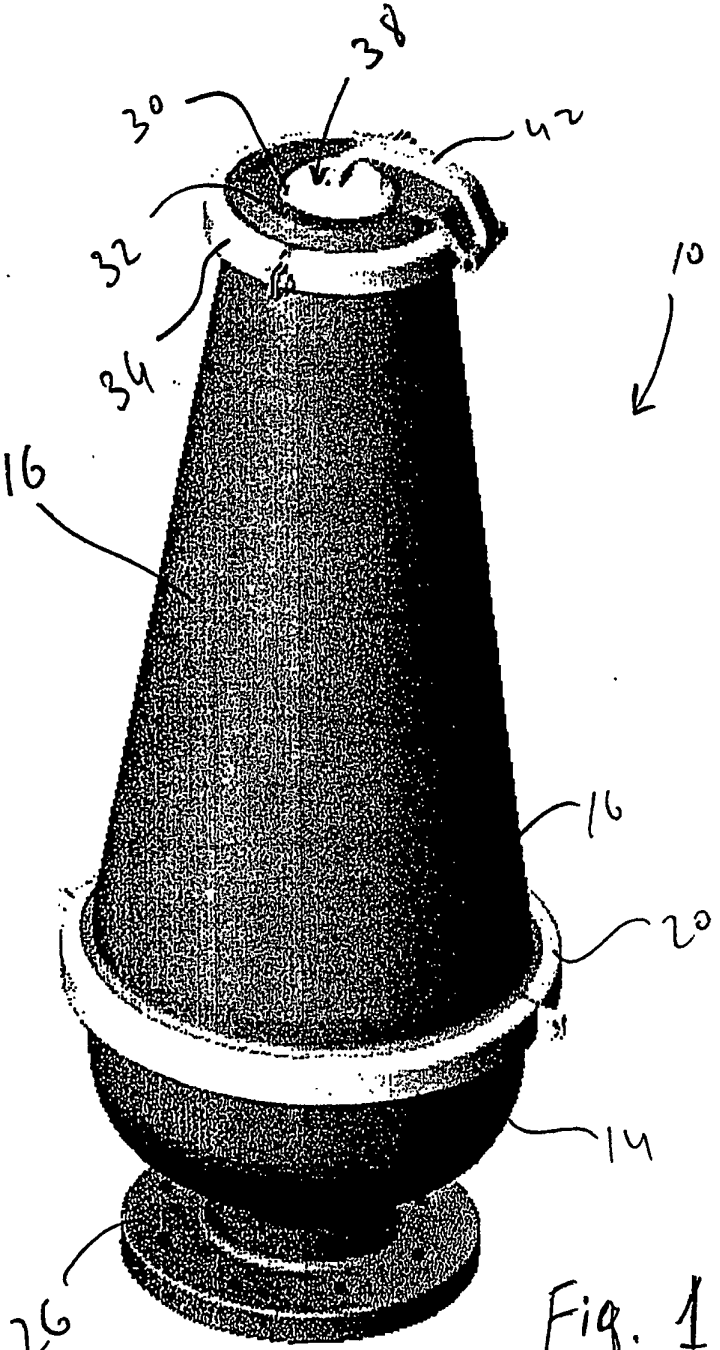

Fig. 1A

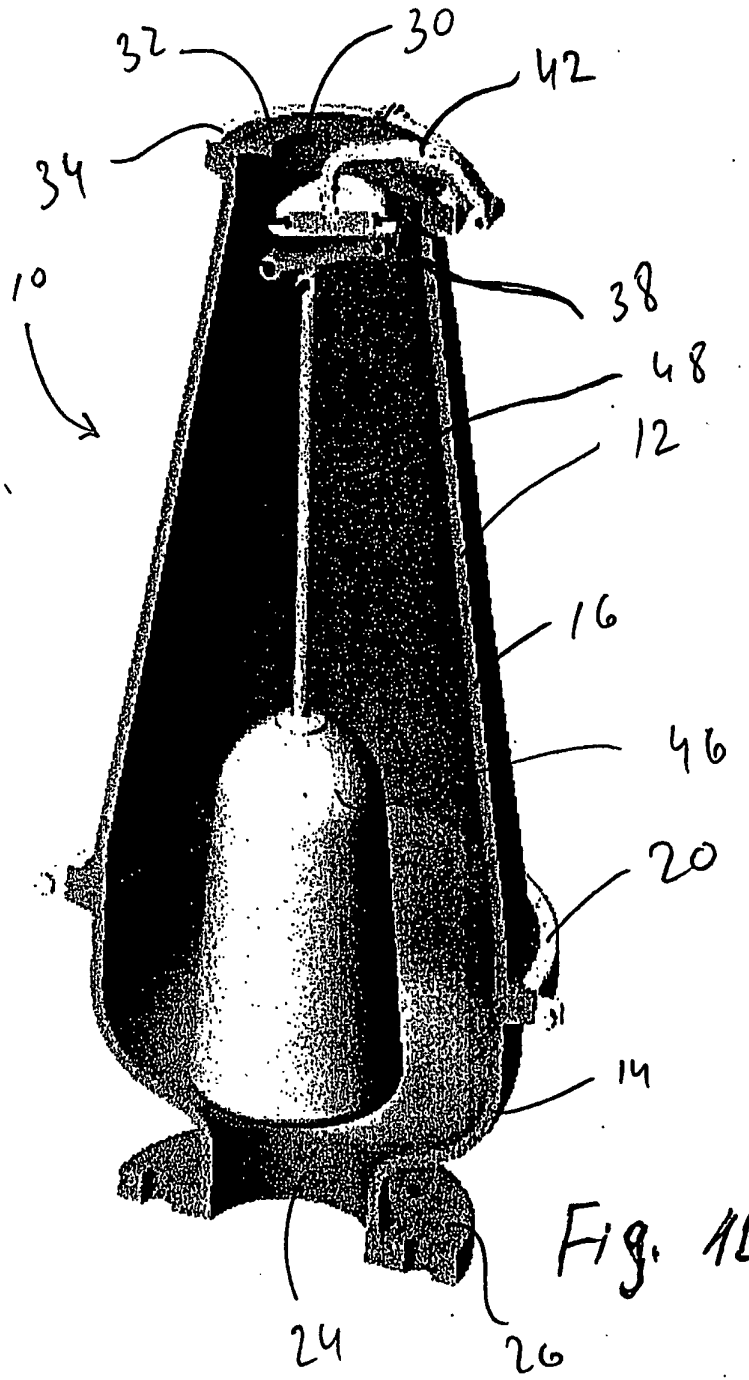

Fig. 1B

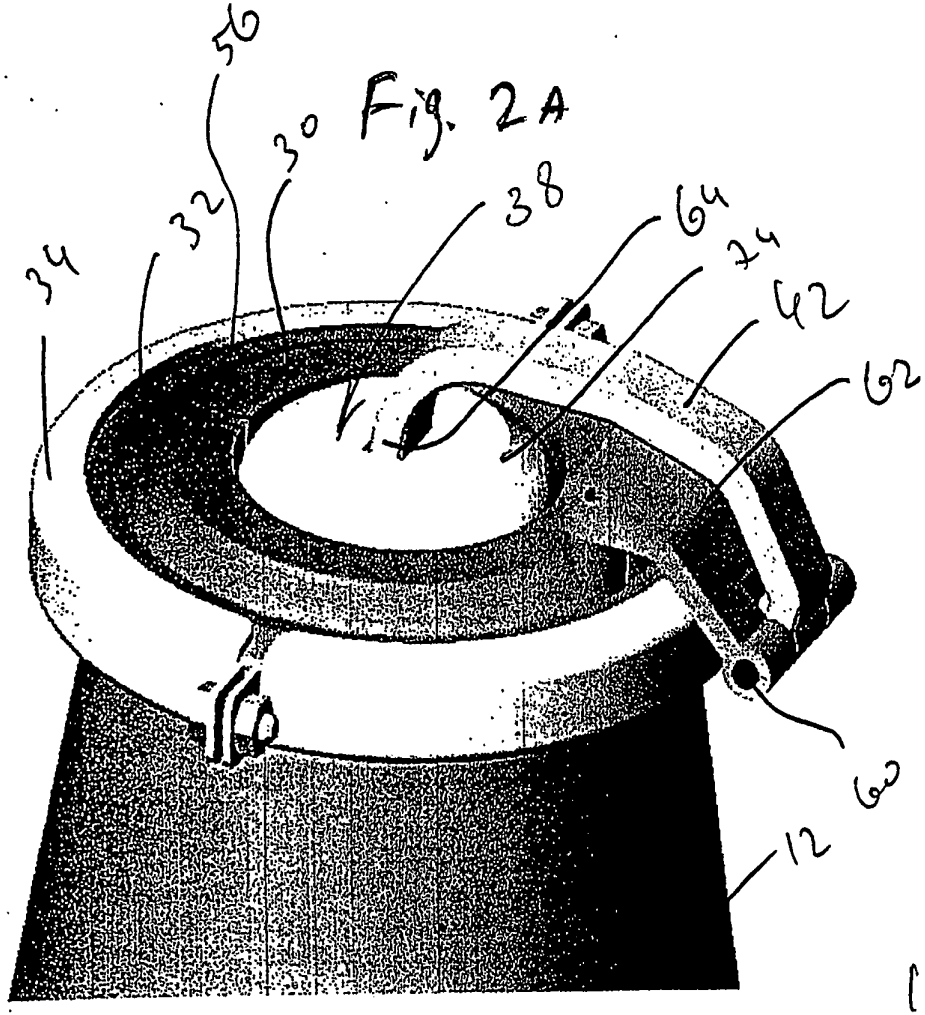

Fig. 2A

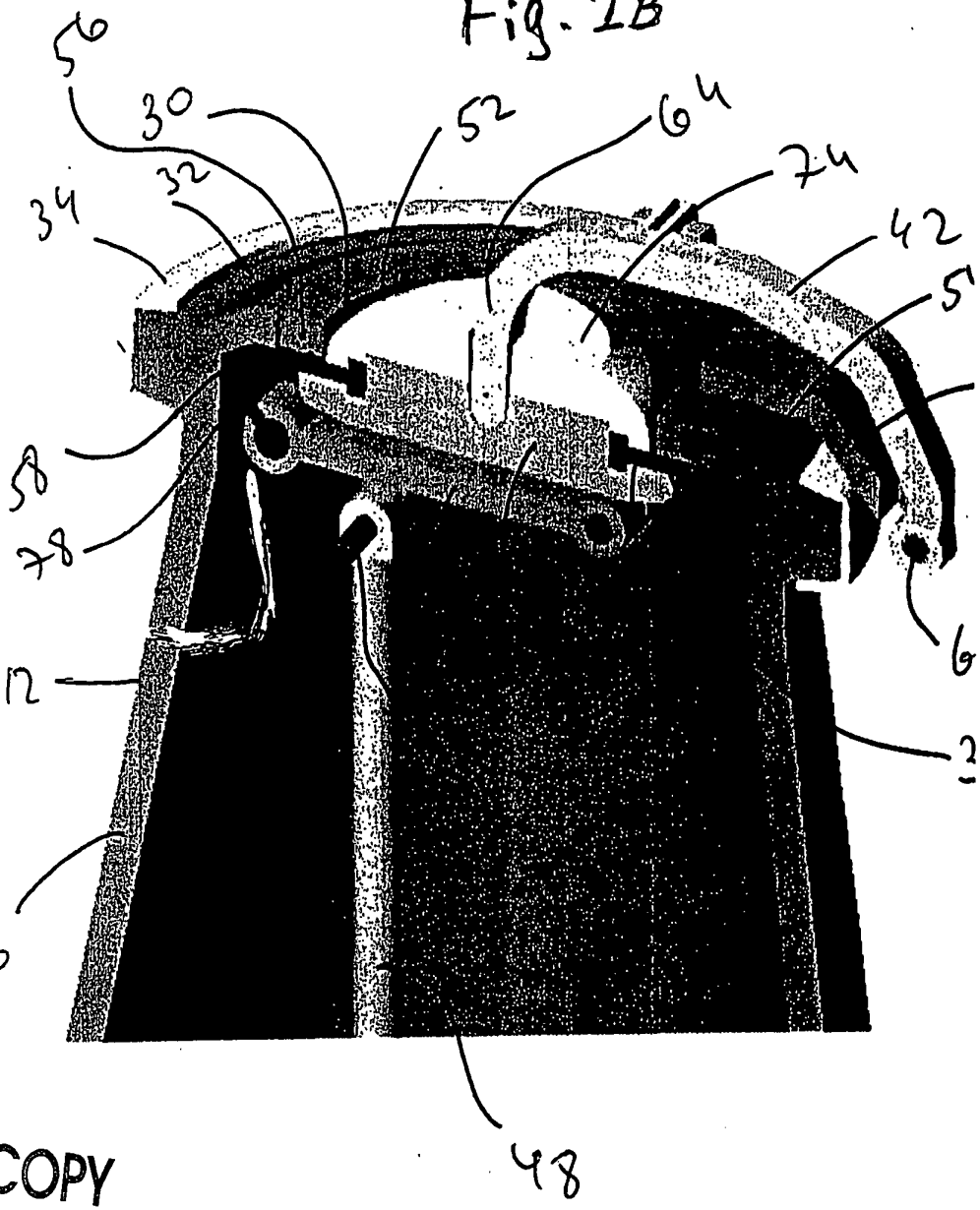

Fig. 2B

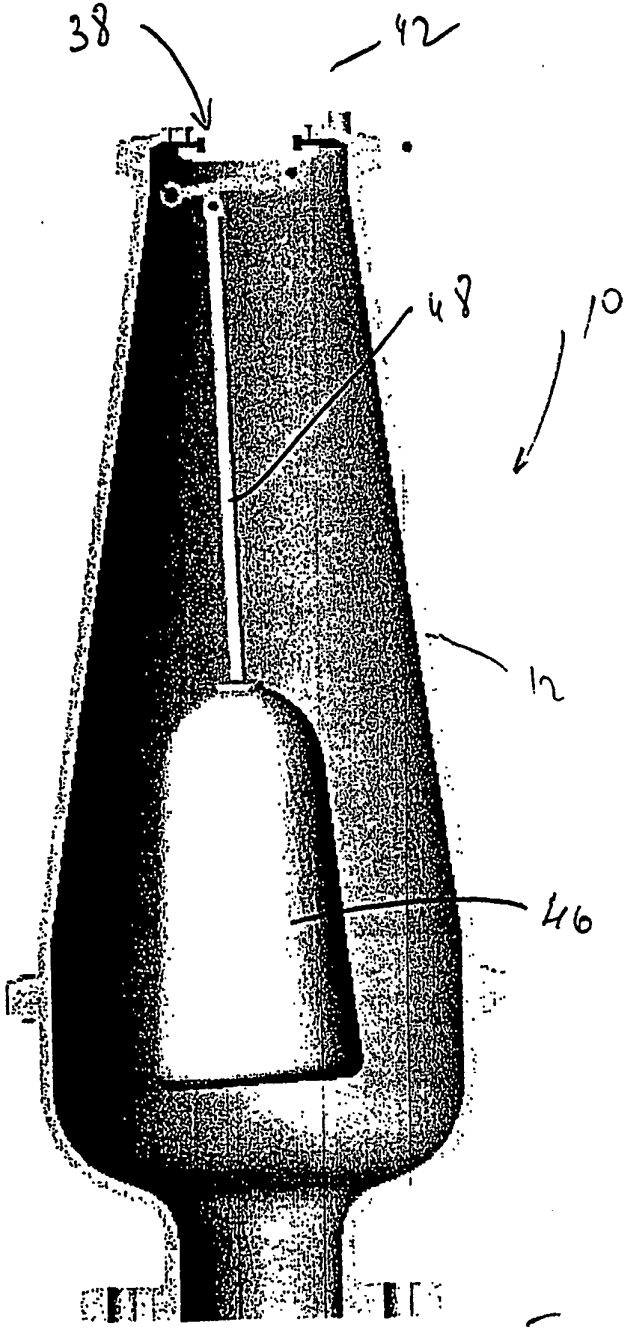

Fig. 3A

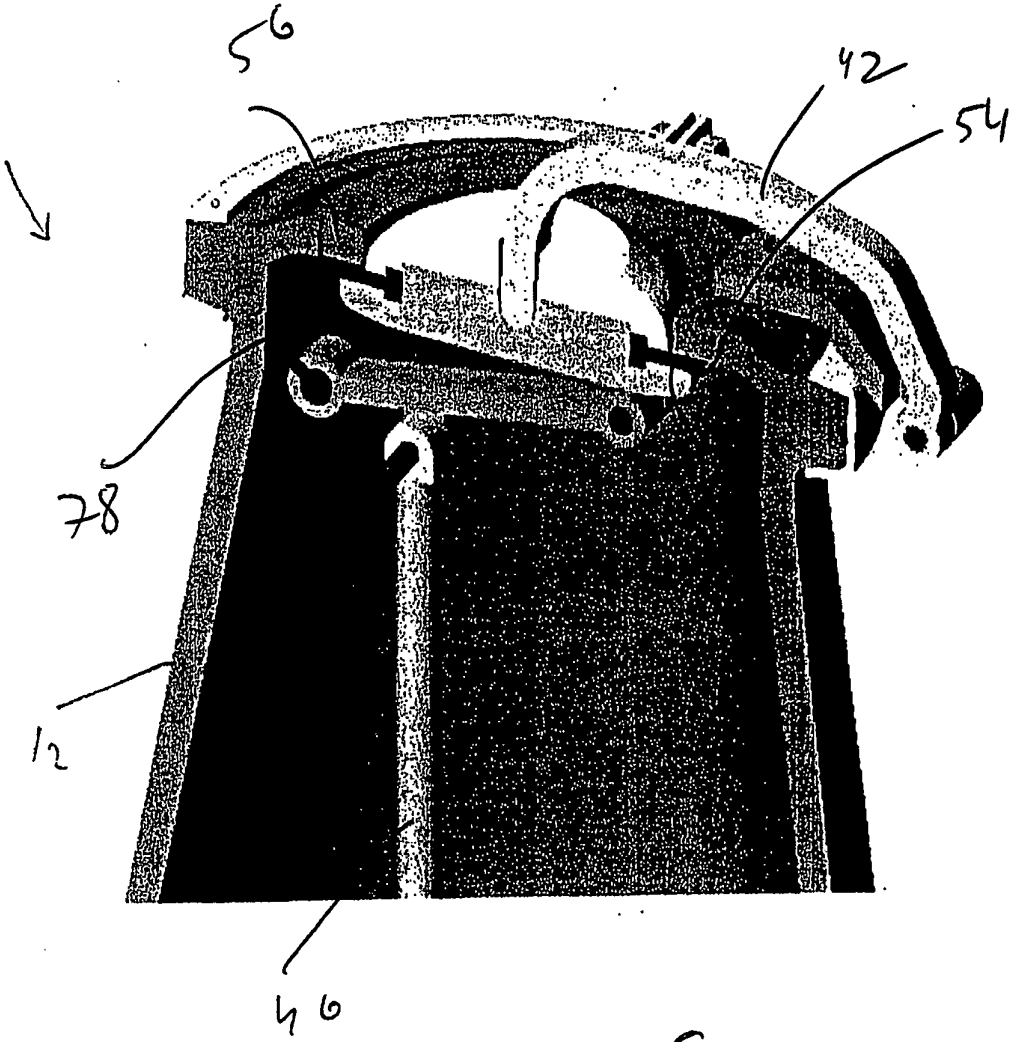

Fig. 3B

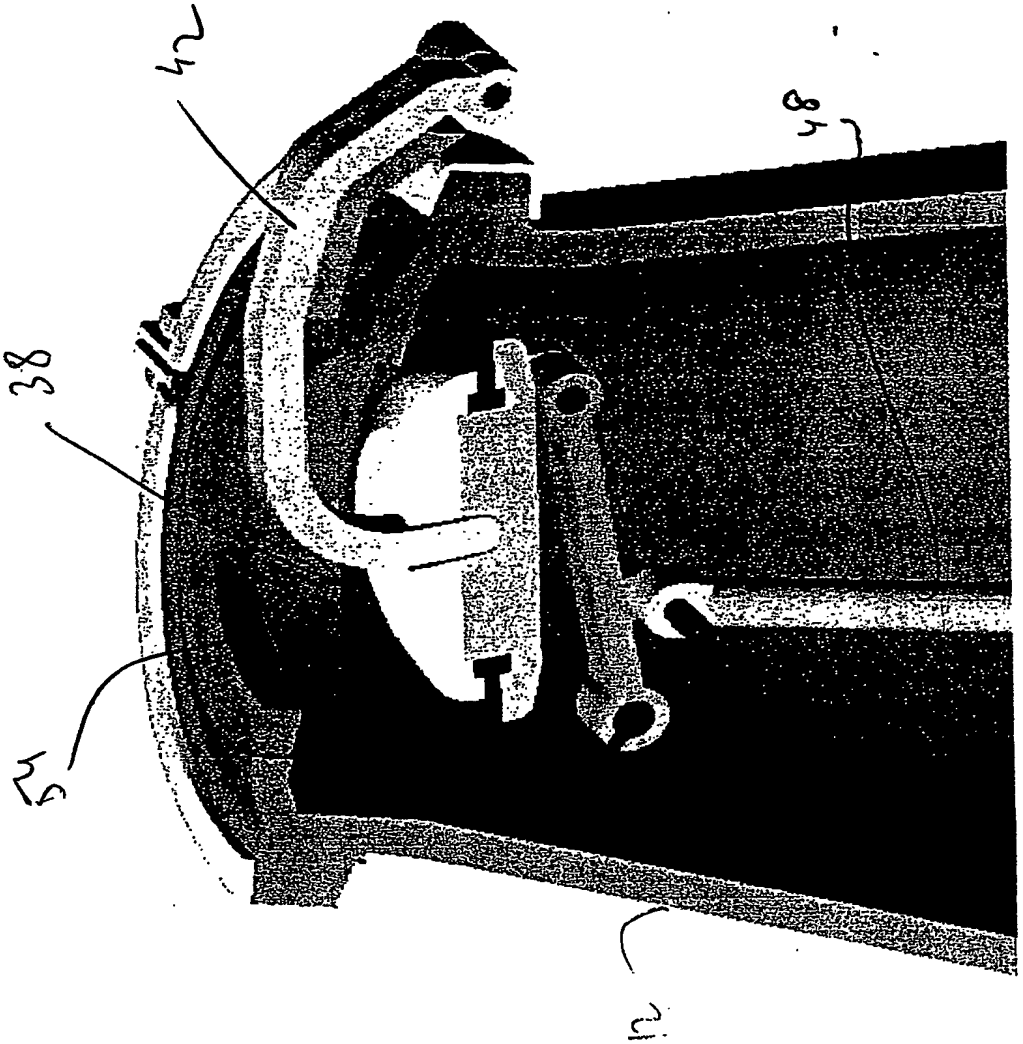

Fig. 4B

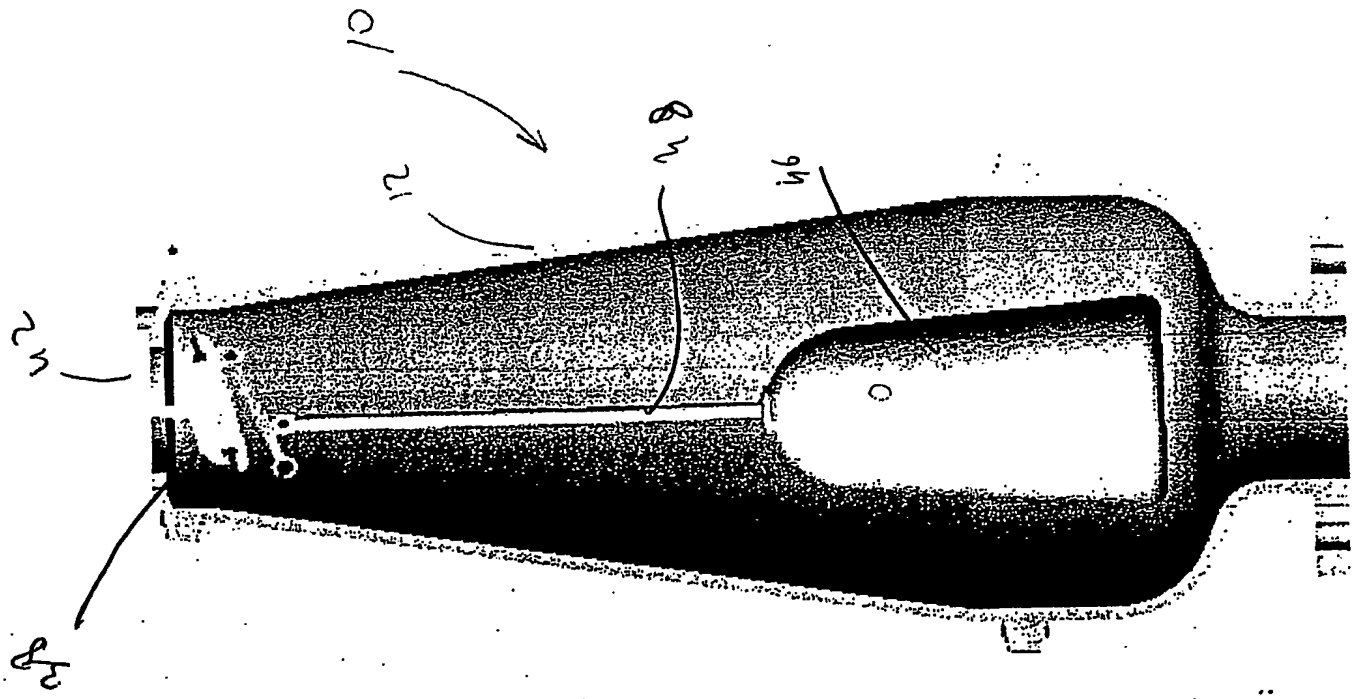

Fig. 4A

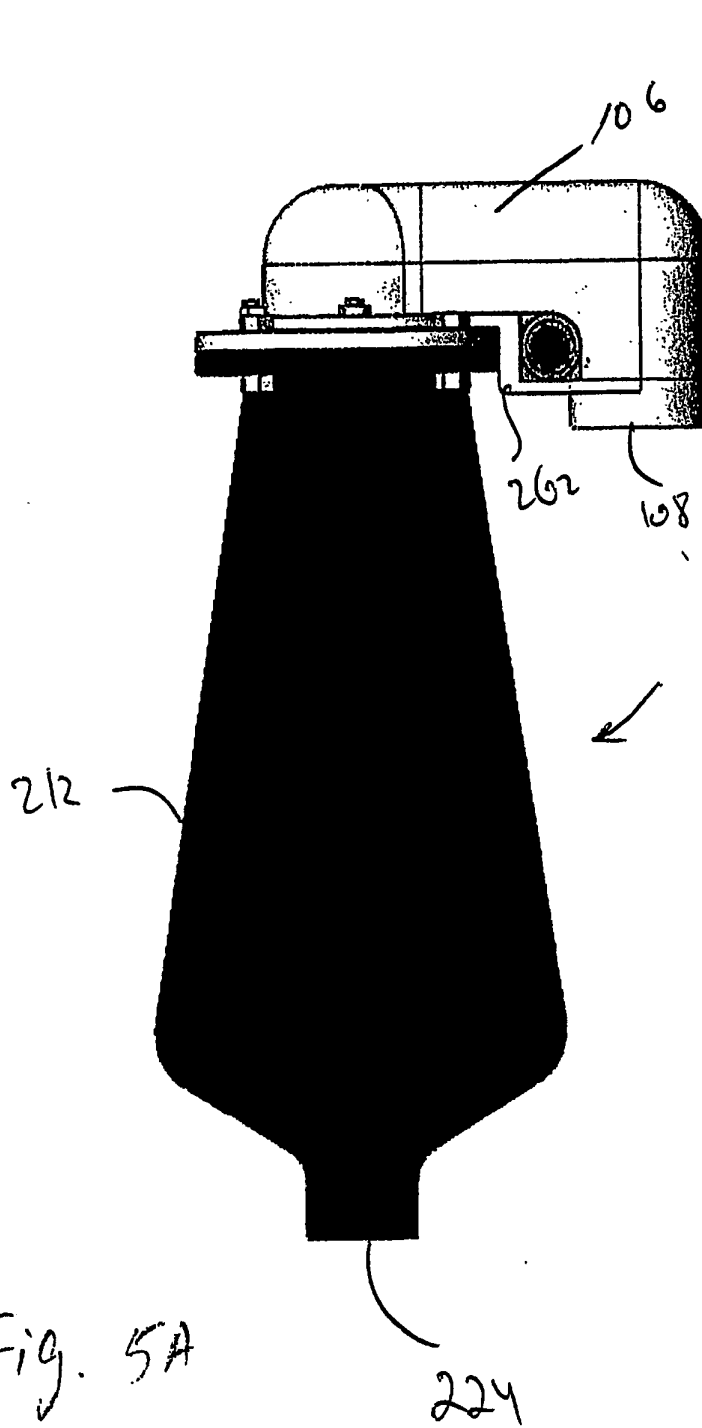

Fig. 5A

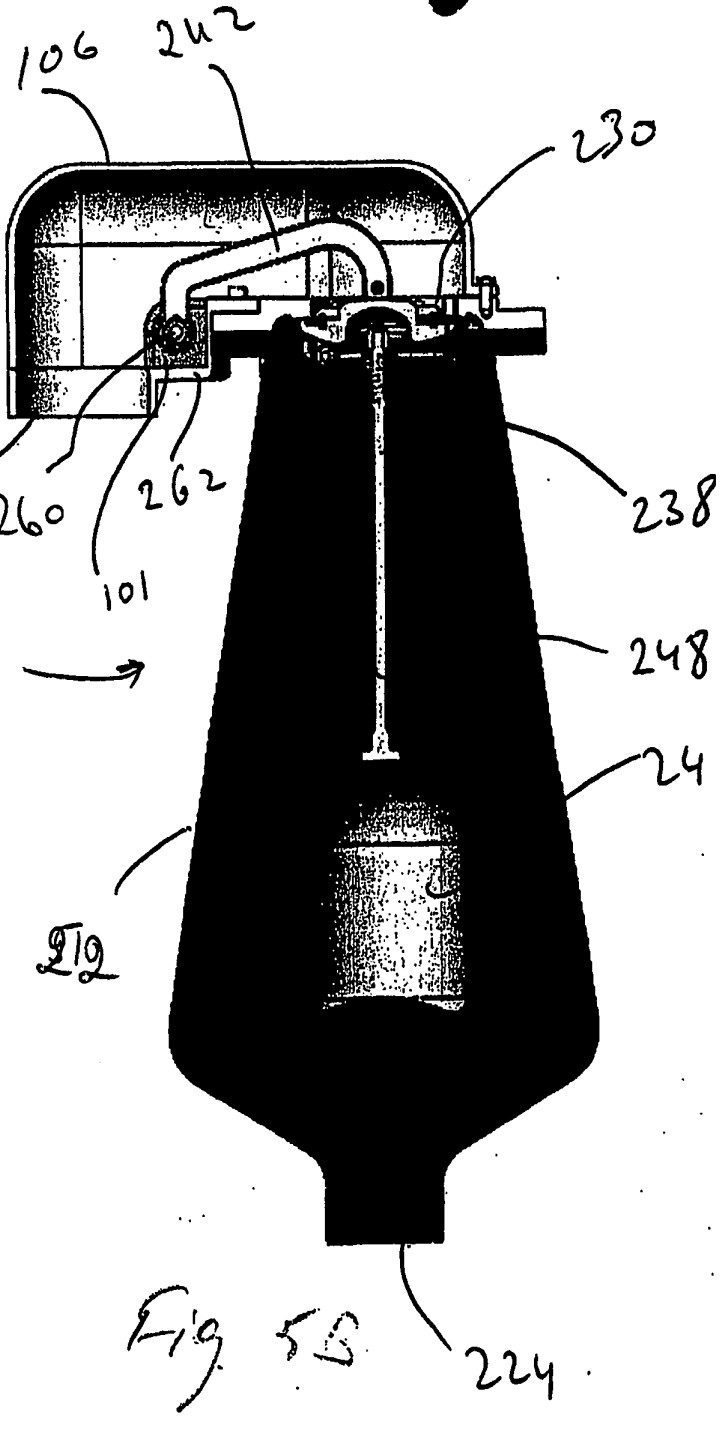

Fig. 5B

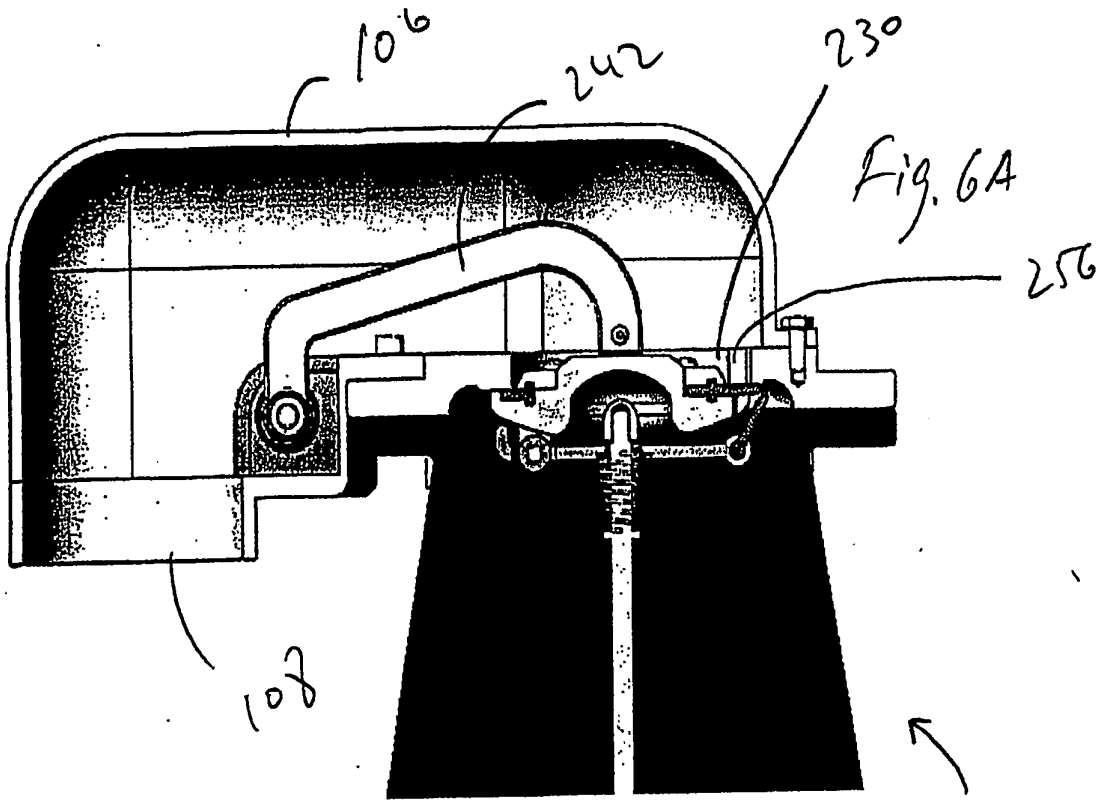

Fig. 6A

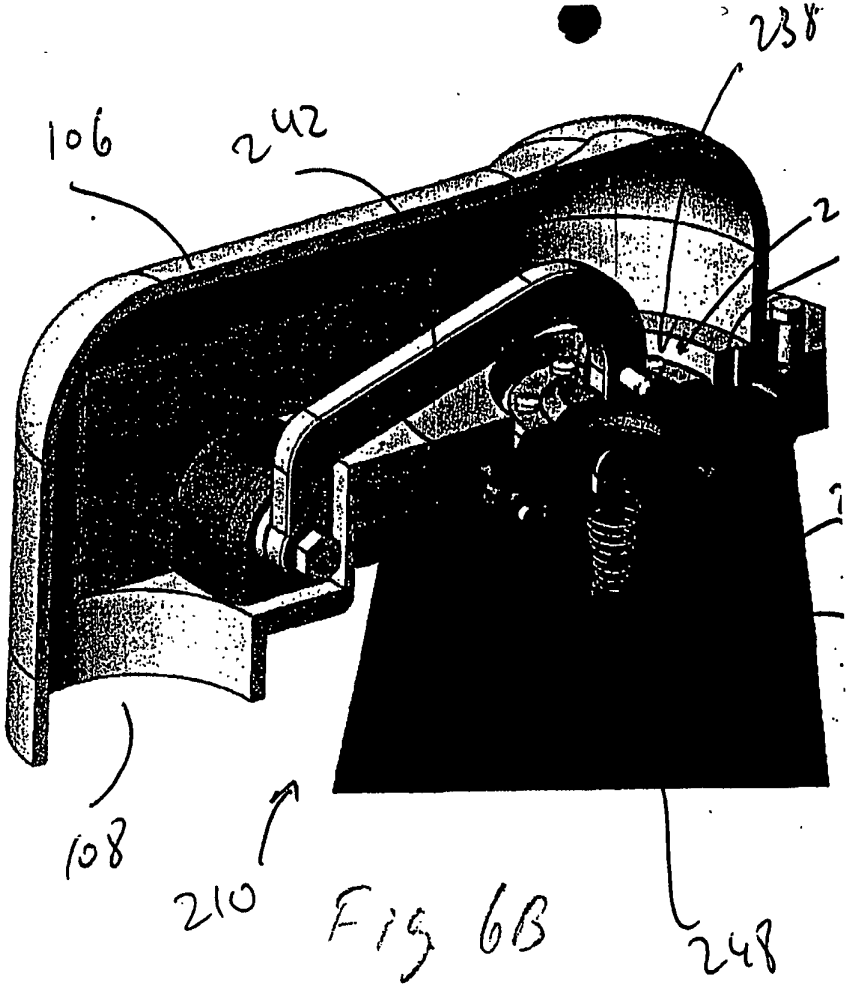

Fig. 6B

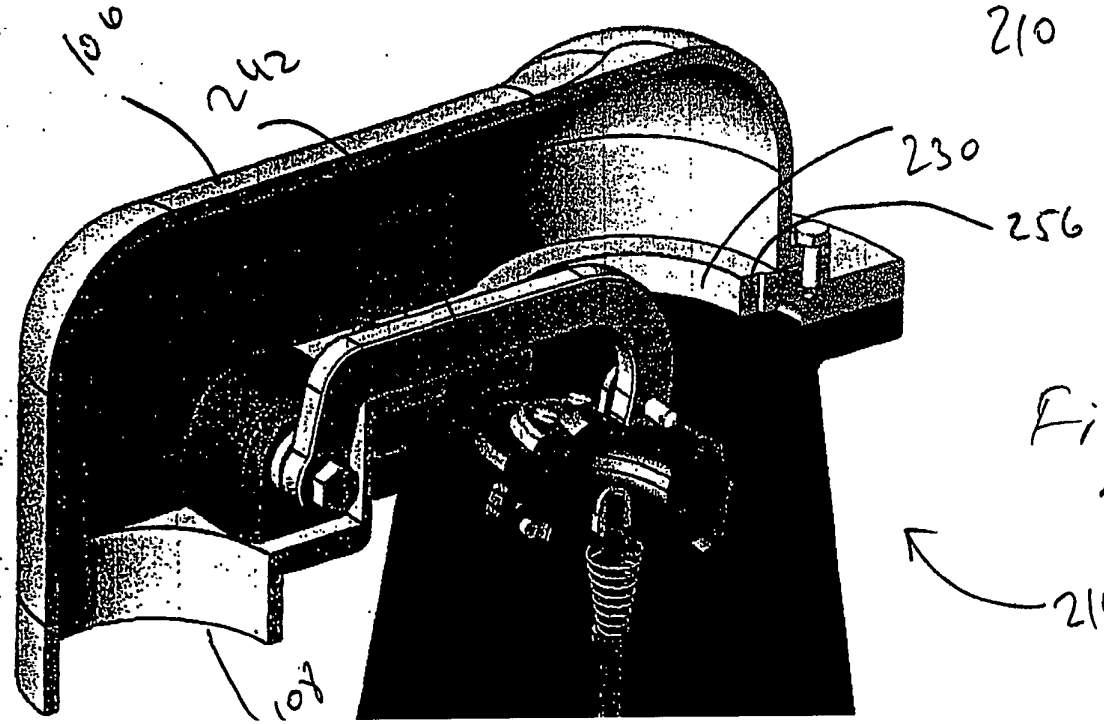

Fig. 6C

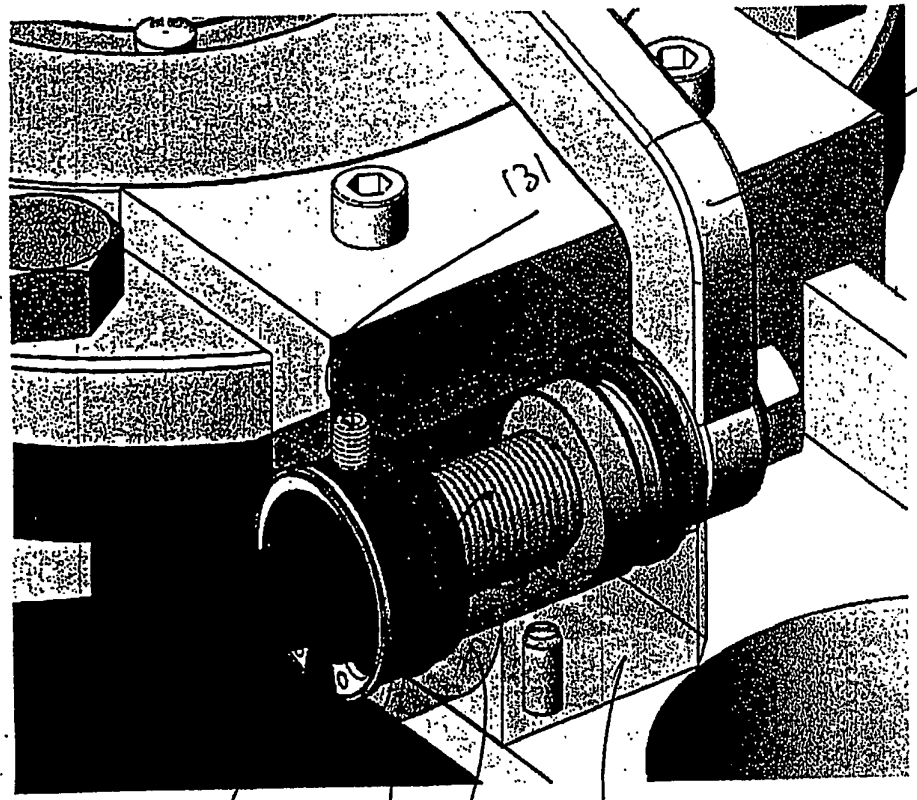

Fig. 7B

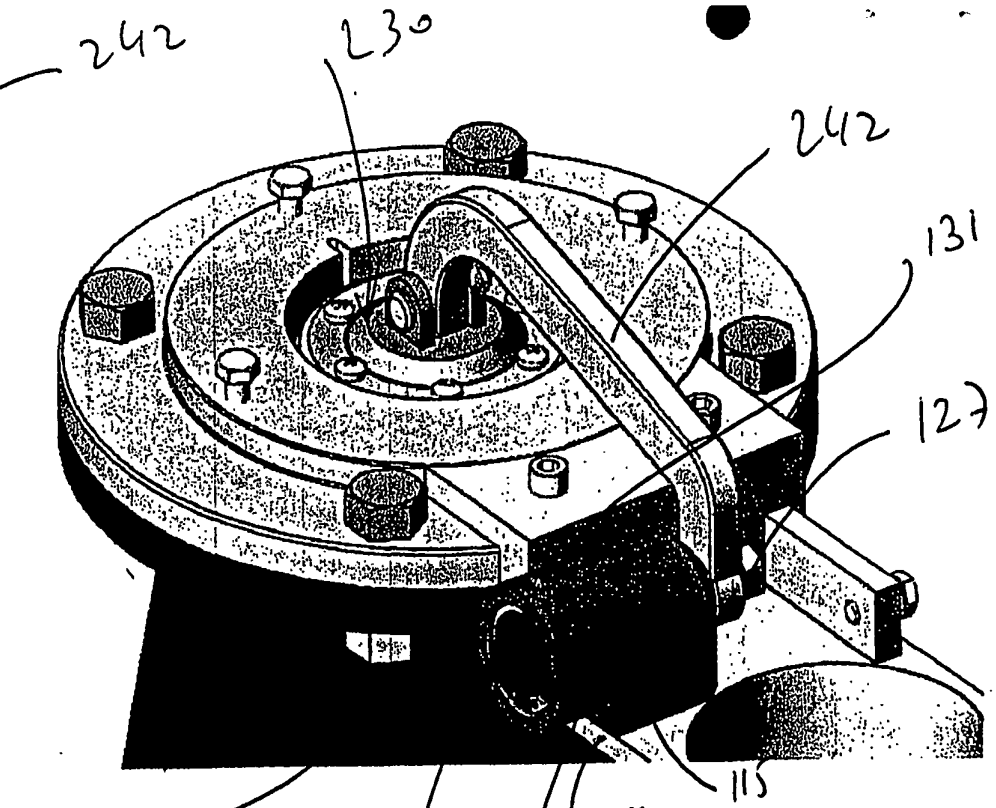

Fig. 7A

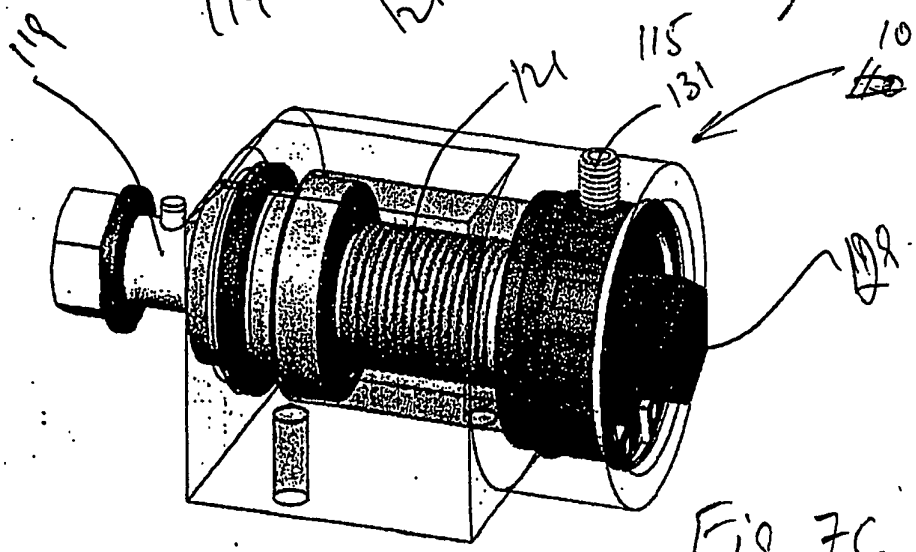

Fig. 7C

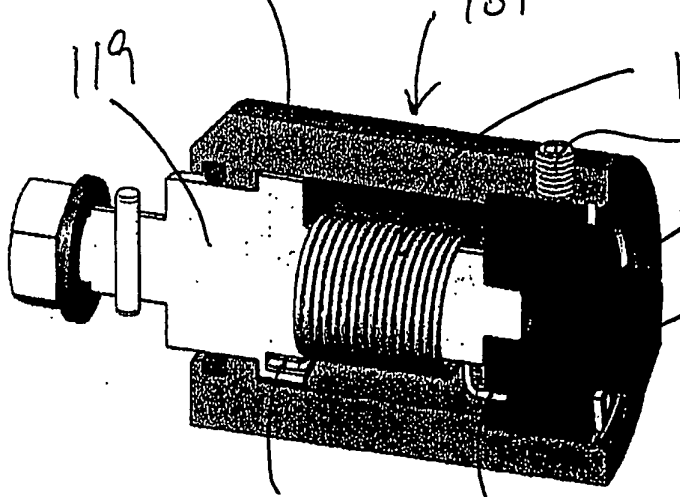

Fig. 7D

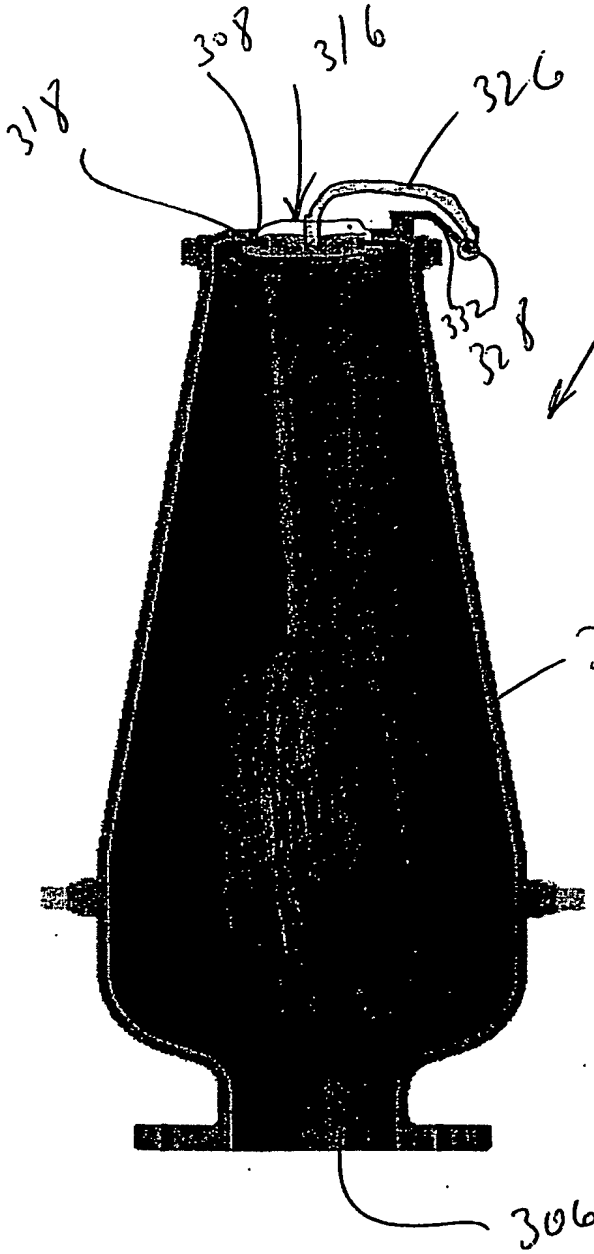

Fig. 8A

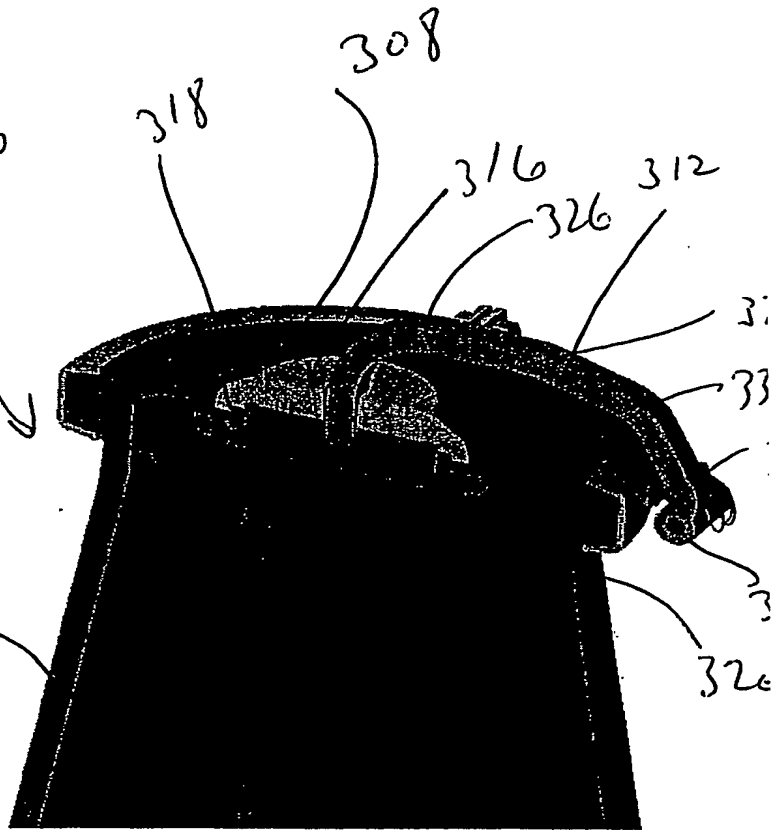

Fig. 8B